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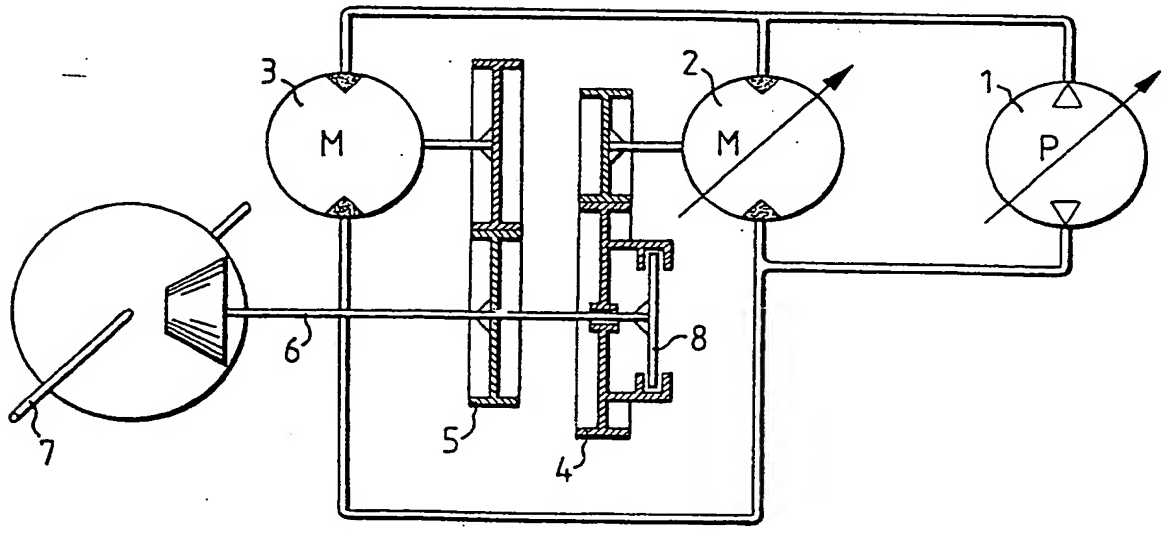
(54) Hydrostatic drive mechanism

(57) A hydrostatic drive mechanism is provided for a self-propelled vehicle and includes at least two hydraulic drive motors 2, 3 for driving the vehicle *via* respective drive trains and, connected hydraulically in parallel to the motors, a common adjustable feed pump 1. The first motor 2 is a variable-displacement motor and includes, in its drive train, a clutch 8, the arrangement being such that hydraulic fluid from the feed pump can be prevented from flowing through the first motor 2, at which stage the clutch 8 is used to disconnect the motor 2 from the common output shaft 6. The motor 3 is fixed or variable and may act directly on the shaft 6.



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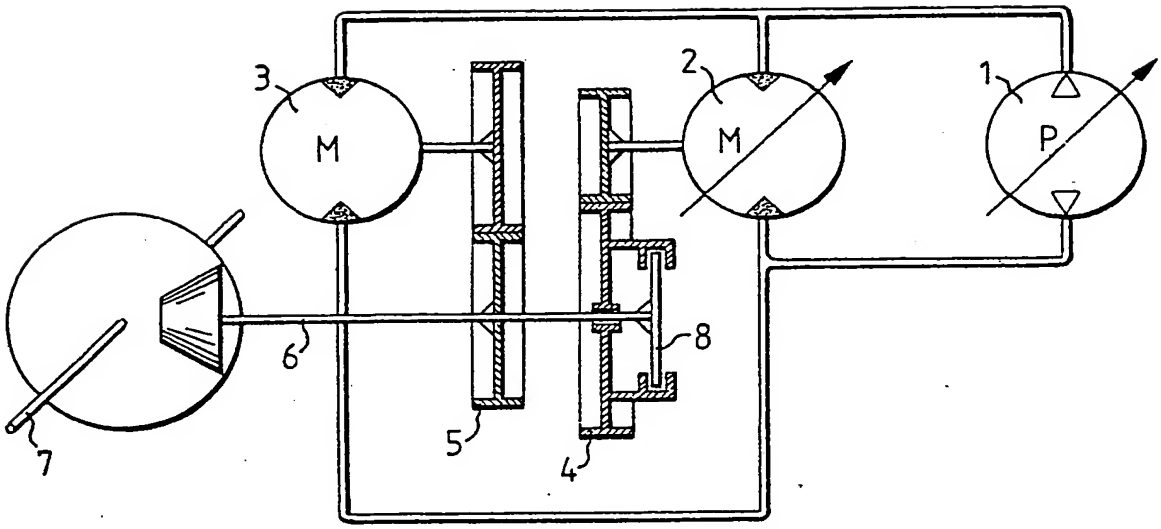
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Hydrostatic Drive Mechanism

The invention is concerned with a hydrostatic drive mechanism for a self-propelled machine, and also with a method of operating such a drive mechanism.

The aim of the invention is to produce a purely hydrostatic drive mechanism with two or more drive motors that is infinitely variable across the entire speed range in order to reach speeds of up to about 50 km/h. The drive mechanism should be economical and of compact construction, and suitable for use in earth-moving machines with drive powers of up to 250 hp.

According to the present invention there is provided a hydrostatic drive mechanism for a self-propelled vehicle, the mechanism including at least two hydraulic drive motors for driving the vehicle via respective drive trains and, connected hydraulically in parallel to the motors, a common adjustable feed pump, wherein at least the first motor is a variable-displacement motor and includes, in its drive train, a clutch, the arrangement being such that hydraulic fluid from the feed pump can be prevented from flowing through the first motor.

Preferably, the first motor can be set either to neutral or to automatic interlock.

Preferably, at least one of the drive trains includes a transmission gear.

The transmission ratios of the drive trains of the first motor and the second motor may be different from

one another, and preferably the transmission ratio of the drive train of the first motor is greater than the transmission ratio of the drive train of the second motor.

The drive trains of both motors may include a common output shaft, which may be an axle drive shaft. The second motor may be arranged to drive the output shaft directly.

Alternatively, the drive trains of the first and second motors may include different axle drive shafts, the drive trains being arranged such that, in operation. the motors drive the driven wheels with a common circumferential speed.

The present invention further provides a hydrostatic drive mechanism for a self-propelled vehicle, the mechanism including a plurality of drive motors fed, in use, from a common adjustable drive mechanism pump, wherein at least a first motor, which is a variable-displacement motor that can be set to a neutral position, and a second motor are connected hydraulically in parallel and are arranged to act, at least one of them via a transmission gear, on a common output, a clutch being provided between the first motor and the output.

The second motor may be either a variable-displacement motor that can be set to neutral, or a fixed-displacement motor.

According to the present invention there if further provided a method of operating a hydrostatic drive

mechanism as described above, in which at relatively low vehicle speeds, both drive motors drive the vehicle and at relatively high drive speeds hydraulic fluid is prevented from flowing through the first motor, and the clutch is disengaged, so that only the second motor drives the vehicle.

Preferably, when only the second motor is driving the vehicle, the first motor is set either to neutral or to automatic interlock.

Initially, the or each variable-displacement motor may be set to maximum absorption volume and the opening angle of the pump gradually increased to increase the vehicle drive speed. Preferably, when the pump has reached maximum opening angle, the swing angle of the first pump is gradually decreased to increase further the vehicle drive speed and, when the swing angle of the first motor reaches a predetermined minimum value, hydraulic fluid is prevented from flowing through the motor and the clutch is disengaged. The minimum value may be determined according to the maximum permitted rotational speed of the first motor or to economic criteria. Preferably, when hydraulic fluid is prevented from flowing through the first motor, the opening angle of the pump is automatically decreased by an amount corresponding to the previous absorption volume of the motor, and is then gradually increased again to increase yet further the vehicle drive speed.

If the second motor is a variable-displacement

motor, when, whilst hydraulic fluid is prevented from flowing through the first motor, the pump reaches maximum opening angle, the swing angle of the second motor may be decreased gradually to increase yet further the vehicle drive speed.

The vehicle drive speed is reduced by carrying out in reverse the method described in the preceding paragraphs.

The present invention yet further provides a method of operating, in a self-propelled vehicle, a drive mechanism as described above, the method including the following steps:

(a) when starting the self-propelled vehicle, the drive motors are set to full absorption volume and are fed from the drive mechanism pump at an increasing opening angle,

(b) when the drive mechanism pump reaches full opening angle, the first motor is gradually swung back to a limiting position determined by technical or economic criteria,

(c) when the limiting position is reached, the adjusting angle of the first motor is brought abruptly into either neutral or automatic interlock, the opening angle of the drive mechanism pump is throttled back by an amount that corresponds to the most recent absorption volume of the first motor, and the clutch is disengaged,

(d) the opening angle of the drive mechanism pump is increased again to full opening angle, and

(e) to reduce the drive speed of the vehicle, the steps described above are carried out in reverse.

If the second motor is a variable-displacement motor, after carrying out step (d), the second motor is preferably gradually swung back to a limiting position corresponding to its maximum permitted rotational speed, determined by technical or economic criteria.

The advantage of the invention consists in that the controlling gears previously used in this speed range, and their automatic controlling systems, can be dispensed with. As a result, the workload of the driver when driving the vehicle is reduced, and opportunities are opened up for new vehicle configurations by virtue of the freer arrangement of the components, in particular of the drive mechanism arrangements, which can be provided on one or more axles.

An embodiment of the invention will be described, by way of example, by comparison with the accompanying drawing, which shows an infinitely-variable hydrostatic drive mechanism for a self-propelled machine, with several drive motors, the mechanism shown being in accordance with the invention claimed in British patent application No. 90.04676.

In the mechanism shown in the drawing, a common adjustable drive mechanism pump 1 is connected via a parallel hydraulic circuit to a variable displacement motor 2, that can be set to neutral, and a fixed displacement motor 3.

The variable displacement motor 2 and the fixed displacement motor 3 act via a disengagable transmission gear 4 and a permanently-engaged transmission gear 5 respectively on a common output shaft 6, which may be an axle drive shaft which engages with an axle drive mechanism 7.

A clutch 8 is provided between the variable displacement motor 2 and the output shaft 6. Although, in the drawing, the clutch 8 is shown installed between the transmission gear 4 and the output shaft 6, it could alternatively be installed between the variable displacement motor 2 and the transmission gear 4.

The transmission ratios of the disengagable transmission gear 4 and the permanently engaged transmission gear 5 are selected to be different from one another in relation to the output shaft 6. The ratio of the permanently-engaged transmission gear 5 of the fixed displacement motor is approximately 1:1 and, the disengagable transmission gear 4, which is connected to the variable displacement motor 2, has a larger ratio.

Alternative configurations of the drive mechanism, which are not shown in the drawings, are of course possible. For example, the variable displacement motor 2 and the fixed displacement motor 3 may be arranged to operate on different drive shafts through the intermediary of transmission gears. The transmission ratio to be observed overall between each drive motor and the output must relate to a common output variable that is

then always present. In this case, for example, the circumferential speed of the driven wheels can be used as a basis.

It is also possible for the fixed displacement motor 32 to operate without the intermediary of a transmission gear by acting directly on the output 6.

In the present invention, the fixed displacement motor 3, i.e. the motor with constant absorption volume, is replaced by a drive motor with an adjustable absorption volume corresponding to that of the variable displacement motor 2.

The drive mechanism operates as follows: when a high tractive force is required, for example at relatively low speeds, both drive motors 2, 3, set to full absorption volume, act on the drive axle. Once the drive mechanism pump 1 has reached its full opening angle, corresponding to the maximum delivery volume, the variable displacement motor 2, which has the possibility of the adjusting angle $\alpha = 0$, starts to swing back, until the swivel angle is such that either the maximum permissible rotational speed for this variable displacement motor is reached, or, on account of the deteriorating efficiency with reducing adjusting angle, any further integrated operation of the two motors can be dispensed with. Once this limiting position has been reached, the variable displacement motor 2 is brought quickly to the adjusting angle $\alpha = 0$, or at least into the range of automatic interlock, and is

disconnected from the output shaft 6 by the clutch 8. At the same time, the drive mechanism pump 1 is swung back temporarily because a partial oil stream is no longer flowing to the variable displacement motor 2.

In order to increase the driving speed further by means of the fixed displacement motor 3 which is still operating, the drive mechanism pump 1 begins to swing out again. The final speed is reached when the fixed displacement motor 3 (or, in the case of a construction with several fixed displacement motors, when these fixed displacement motors, or alternatively, when using one or more variable displacement motors, these variable displacement motors) reaches the maximum permitted rotational speed determined according to technical and economic criteria.

When the speed is reduced from the higher speed ranges, the individual steps and processes described above proceed in reverse. If a large tractive force is required in the lower speed range, the clutch 8 closes again and the variable displacement motor 2 is set into operation.

CLAIMS:

1. A hydrostatic drive mechanism for a self-propelled vehicle, the mechanism including at least two hydraulic drive motors for driving the vehicle via respective drive trains and, connected hydraulically in parallel to the motors, a common adjustable feed pump, wherein at least the first motor is a variable-displacement motor and includes, in its drive train, a clutch, the arrangement being such that hydraulic fluid from the feed pump can be prevented from flowing through the first motor.

2. A mechanism according to claim 1, in which the first motor can be set either to neutral or to automatic interlock.

3. A mechanism according to claim 1 or claim 2, in which at least one of the drive trains includes a transmission gear.

4. A mechanism according to any one of the preceding claims, in which the transmission ratios of the drive trains of the first motor and the second motor are different from one another.

5. A mechanism according to claim 4, in which the transmission ratio of the drive train of the first motor is greater than the transmission ratio of the drive train of the second motor.

6. A mechanism according to any one of the preceding claims, in which the drive trains of both motors

include a common output shaft.

7. A mechanism according to claim 6, in which the common output shaft is an axle drive shaft.

8. A mechanism according to claim 6 or claim 7, in which the second motor is arranged to drive the output shaft directly.

9. A mechanism according to any one of claims 1 to 5, in which the drive trains of the first and second motors include different axle drive shafts, the drive trains being arranged such that, in operation, the motors drive the driven wheels with a common circumferential speed.

10. A hydrostatic drive mechanism for a self-propelled vehicle, the mechanism including a plurality of drive motors fed, in use, from a common adjustable drive mechanism pump, wherein at least a first motor, which is a variable-displacement motor that can be set to a neutral position, and a second motor are connected hydraulically in parallel and are arranged to act, at least one of them via a transmission gear, on a common output, a clutch being provided between the first motor and the output.

11. A mechanism according to any one of the preceding claims, in which the second motor is a variable-displacement motor that can be set to neutral.

14. A method of operating a hydrostatic drive mechanism according to any one of the preceding claims, in which at relatively low vehicle speeds, both drive motors drive the vehicle and at relatively high drive speeds hydraulic fluid is prevented from flowing through the first motor, and the clutch is disengaged, so that only the second motor drives the vehicle.

15. A method according to claim 14 in which, when only the second motor is driving the vehicle, the first motor is set either to neutral or to automatic interlock.

16. A method according to claim 14 or claim 15, in which initially the or each variable-displacement motor is set to maximum absorption volume and the opening angle of the pump is gradually increased to increase the vehicle drive speed.

17. A method according to claim 16 in which, when the pump has reached maximum opening angle, the swing angle of the first pump is gradually decreased to increase further the vehicle drive speed.

18. A method according to claim 17, in which when the swing angle of the first motor reaches a predetermined minimum value, hydraulic fluid is prevented from flowing through the motor and the clutch is disengaged.

19. A method according to claim 18, in which the

minimum value is determined according to the maximum permitted rotational speed of the first motor or to economic criteria.

20. A method according to claim 18 or claim 19, in which when hydraulic fluid is prevented from flowing through the first motor, the opening angle of the pump is automatically decreased by an amount corresponding to the previous absorption volume of the motor, and is then gradually increased again to increase yet further the vehicle drive speed.

21. A method according to any one of claims 14 to 20 of operating a drive mechanism according to claim 11, in which when, whilst hydraulic fluid is prevented from flowing through the first motor, the pump reaches maximum opening angle, the swing angle of the second motor is decreased gradually to increase yet further the vehicle drive speed.

22. A method according to any one of claims 14 to 21, in which the vehicle drive speed is reduced by carrying out in reverse the method of any one of those claims.

23. A method of operating, in a self-propelled vehicle, a drive mechanism according to claim 10, the method including the following steps:

(a) when starting the self-propelled vehicle, the drive motors are set to full absorption volume and are fed from the drive mechanism pump at an increasing opening angle,

(b) when the drive mechanism pump reaches full opening angle, the first motor is gradually swung back to a limiting position determined by technical or economic criteria,

(c) when the limiting position is reached, the adjusting angle of the first motor is brought abruptly into either neutral or automatic interlock, the opening angle of the drive mechanism pump is throttled back by an amount that corresponds to the most recent absorption volume of the first motor, and the clutch is disengaged,

(d) the opening angle of the drive mechanism pump is increased again to full opening angle, and

(e) to reduce the drive speed of the vehicle, the steps described above are carried out in reverse.

24. A method according to claim 23 of operating a drive mechanism according to claim 11, in which after carrying out step (d), the second motor is gradually swung back to a limiting position corresponding to its maximum permitted rotational speed, determined by technical or economic criteria.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9219276.4

Relevant Technical fields

(i) UK Cl (Edition K) F2W

(ii) Int Cl (Edition 5) F16H

Search Examiner
A BURROWS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search
5 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1-24

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2119905 A	(ZAHNRADFABRIK) Whole document	1-3, 10, 11, 14
X	GB 2089007 A	(SUNDSTRAND) Whole document	1-3, 10, 11, 14
X	GB 2083893 A	(ZAHNRADFABRIK) Whole document	1-3, 10, 11, 14
X	GB 1601239	(MUIR-HILL) Lines 56-72, page 1	1-3, 10-12, 14
X	GB 0026115 A2	(ETAT-FRANCAIS) Whole document	1-8, 10-12, 14
X	WO 80/01668 A1	(LARSON) Figure 1 lines 23, 24 page 3, lines 19, 20 page 7	1-3, 10-12, 14

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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